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SECTION 319 NONPOINT SOURCE POLLUTION CONTROL PROGRAM

WATERSHED PROJECT FINAL REPORT

Segment 3C Characterization Project
Arrastra Basin
WQC02000019

By

William Simon, Animas Watershed Coordinator
For San Juan RC & D (project sponsor) and the ARSG

August 31, 2004

This project was conducted in cooperation with the State of Colorado and the United States Environmental Protection Agency, Region 8.

Grant # WQC02000019

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EXECUTIVE SUMMARY

PROJECT TITLE: Arrastra Gulch Characterization Project (Segment 3c)

PROJECT START DATE: 9/4/01 Project Completion Date: 8/31/04

FUNDING:	TOTAL BUDGET	$11,500
	TOTAL EPA GRANT	$11,500
	TOTAL EXPENDITURES OF EPA FUNDS	$ 9,912.85
	TOTAL SECTION 319 MATCH ACCRUED	Match not required

SUMMARY OF ACCOMPLISHMENTS:

The funds for this project were used to successfully to accomplish the project goals. Water quality throughout the Arrastra Creek basin was monitored at both high and low flows. In addition a survey for macro invertebrates was completed. The upper elevations of the basin which included Silver Lake proved difficult to access. Water samples and macroinvertebrate samples were taken but more work remains to be done to determine if aquatic life improvements can be made. The ARSG is currently developing plans to fly in a raft and hydro-lab that will assist with further characterization of this large and deep water body that currently supports minimal aquatic life.

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INTRODUCTION

This is the final report for the Arrastra Creek Characterization Project (WQC02000019) funded in March, 1999 and completed July 31, 2004.

PROJECT GOALS, OBJECTIVES, AND ACTIVITIES

Goal 1: Determine biological condition of Arrastra Gulch.

Objective 1: Implement a biological reconnaissance of the Arrastra Creek aquatic community to help bracket inflows of ground water metal loading and delineate areas of differing water quality.

Task 1. Sample for macroinvertebrates and several locations throughout Arrastra Creek.

Product: Map of bracketed stream segments needing further geochemical analysis.

Goal 2: Determine geochemical conditions throughout Arrastra Creek.

Objective 2: Monitor and characterize geochemical conditions throughout Arrastra Creek and its impact on the Animas River (Segment 3a).

Task 2: Take water samples at various locations

Product: Water Quality Data, Map of sample locations, Recommendations for Standards and an Arrastra Report.

Goal 3: Determine factors limiting aquatic life and determine these sources.

Objective 3: Analyze results of sampling program in Arrastra Creek

Task 3: Analyze water quality data and compare to existing biological condition

Product: Water Quality Data, Map of sample locations, Recommendations for Standards and the Arrastra Report

Objective 4: Evaluate impact of Arrastra Creek on water quality in Segment 3a

Task 4: Analyze results of sampling program in Segment 3a

Product: Water Quality Data, Map of sample locations, inclusion the Report

Goal 4:Determine the feasibility of Silver Lake (upper Arrastra) of sustaining aquatic life, including trout

Objective 5: Determine biological, physical, and geochemical conditions of Silver Lake

Task 5: Monitor existing conditions in Silver Lake

Product: Feasibility of the stream to sustain aquatic life included in Report

Planned and Actual Milestones, Products, and Completion Dates

MILESTONE TABLE - BLUE PRINT INDICATES FINAL STATUS*

Goal & Objective	Task Description	Schedule	Output / Products / Data
Goal 1	Determine biological condition		
Task 1	Sample macroinvertebrates	**Sept. 30, 2001**	Map of the location of future sampling events; bug numbers summary for Report* (see Attachment 1, also see Attachment 3 for a report on macroinvertebrates)
Goal 2	Determine geochemical conditions		
Task 2	Take water quality samples	**2001-2003 Various times**	Water quality data for Report* (completed in spring, 2004, see Attachment 2)
Goal 3	Determine limiting factors and the sources		
Task 3	Water Quality and Biological data analysis	**Mar. 30, 2003**	List of sources and factors limiting aquatic life for Report* (Complete analysis not yet complete but see Attachment 2, water quality data, and attachment 3, Marcoinvertebrate report.
Task 4	Evaluate impact of Arrastra Creek on water quality in Segment 3a	**July 30, 2003**	Known contributions of metals to Segment 3a (Report)* (Preliminary Tracer study results of Segment 3a just in – Arrastra provides insignificant metal loading to Segment 3a)
Goal 4	Feasibility of Silver Lake sustaining aquatic life		
Task 5	Monitor existing conditions in Silver Lake	**July 30, 2003**	Feasibility of stream to sustain aquatic life (Report) (see data for inlet and outlet of the lake in Attachment 2.)

* The tasks have all been complete and we have recently received the lab reports on water quality. A report on the condition of macroinvertebrates is included as Attachment 2.

Evaluation of Goal Achievement and Relationship to the State NPS Management Plan

Task 1: Sample site location map is provided as Attachment 1. A report on the macroinvertebrate population at various locations is provided as Attachment 3.

Task 2: Water quality sample data is provided as Attachment 2

Task 3: Although data collected in this study is now complete preliminary analysis indicates additional information needs to be collected within Silver Lake. This was not possible to do given the time constraints of this program and the remoteness of the site.

Task 4: The impact of metal loading from Arrastra creek on Segment 3a of the Animas has been analyzed through the recent completion of salt and dye tracer studies performed by the USGS, sponsored by ARSG. Preliminary indications there is very minimal loading impacts to the segment. The USGS report will not be available for citation or publication for at least one more year.

Task 5: The existing condition of Arrastra creek and Silver Lake was accomplished by collecting both macroinvertebrate data (Attachment 3) and water quality data (Attachment 2). The information remains to be further analyzed to determine feasibility for improvements but macroinverbrate life is adequate in the creek. Silver Lake aquatic life is quite minimal but we don't know why as yet.

A Report: A final report was intended but this grant ended before that could be complete. A report on factors limiting aquatic life, summary of water quality data analysis, and the feasibility to sustain improved aquatic life throughout the basin is dependent upon more information and further analysis. This report is now scheduled to become a chapter to the revised Animas Use Attainability Analysis which will be presented to the WQCD and WQCC in February, 2006

Supplemental Information - None

BEST MANAGEMENT PRACTICES DEVELOPED AND/OR REVISED
Not applicable

MONITORING RESULTS

BMP Effectiveness Evaluations
Not applicable

Surface Water Improvements
Not applicable

Ground Water Improvements
Not applicable

Other Monitoring
Water quality was monitored at appropriate locations throughout the basin. This resulting data is presented in Attachment 2. Macroinvertebrate monitoring is summarized in Attachment 3.

Quality Assurance Reporting – All monitoring followed the requirements of the Arrastra SAP. No problems with QA were observed.

Results of BMP Operation and Maintenance Reviews
Not applicable

COORDINATION EFFORTS
This project has been accomplished through the coordination of San Juan RC&D, Colorado Division of Wildlife, land owners, and the ARSG. While San Juan RC&D was responsible for administrative formalities, the ARSG Coordinator, with assistance from several volunteers accomplished all water quality samples. B.U.G.S. Consultants did the bug survey with assistance from the Coordinator. They presented their preliminary report at the monthly Stakeholders meeting which was followed by revisions recommended by the group. The CDOW contributed laboratory analysis for most of the project. All phases of the project were thoroughly discussed at monthly ARSG meetings. Future investigations will also be coordinated through the ARSG. The results of this characterization project will be incorporated into the Animas UAA and presented to the WQCD and WQCC. See Attachment 4 for a listing of ARSG participants.

Coordination From Other State Agencies (see above)

Other State Environmental Program Coordination (none)

Federal Coordination

The coordinated office of the U. S. Forest Service and BLM assisted in this project by assigning people to help with the monitoring effort. In addition, BLM and EPA, incooperation with ARSG and San Juan County Historical Society was involved in reviewing many aspects of the Arrastra basin private lands for acquisition.

USDA Programs – see above

Accomplishments Of Agency Coordination Meeting

The planning, implementation, and monitoring of this project were a collaboration of all ARSG participants. All work was accomplished as planned and the information was and will be further evaluated by the Stakeholders.

Resources/Coordination from Federal Land Management Agencies

FLMA participated in the stakeholder process of project development, implementation, and monitoring. No FLMA cash contributions were received.

Other Sources of Funding

The Animas Watershed Coordinator's position, a key position for project development and management, was funded through programs with the Colorado Energy Assistance, Southwestern Water Conservancy District, San Juan County, and a separate NPS 319 grant. San Juan County provided office space, meeting rooms, and a wet lab.

SUMMARY OF PUBLIC PARTICIPATION

The planning, implementation, and monitoring of this project were a collaboration of all ARSG participants. All work was accomplished as planned and the information was and will be further evaluated by the Stakeholders.

ASPECTS OF THE PROJECT THAT DID NOT WORK WELL

Two problems arose. First on two occasions during the synoptic sampling the flow meter broke down resulting in the loss of complete flow data. Second, the upper basin where Silver Lake is located proved to be nearly impossible to access during the high flow period. Ice and deep snow hold the the cliffs of this north facing slope. We finally succeeded in get high flow samples and flow measurements at both the inlet and outlet of the lake.

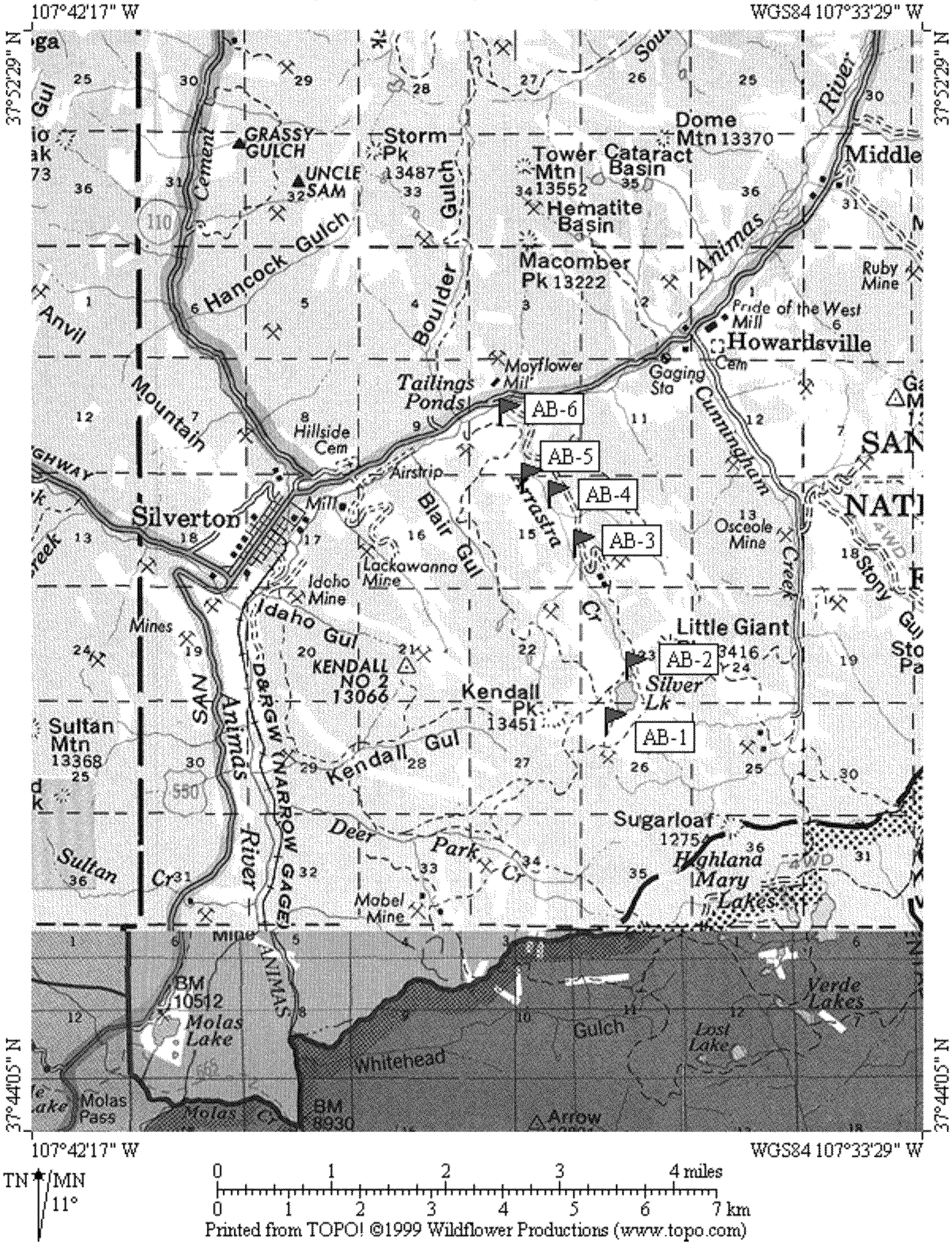
FUTURE ACTIVITY RECOMMENDATIONS

This project did not find any new sources of loading to Arrastra Creek than we had determined in the Animas UAA. It does provide additional and important information regarding seasonal concentrations and loads. The lower basin has healthy macroinvertebrate populations, however no fish. Although metal concentrations are very low, extremely low hardness values indicates that metal toxicity still exists on occasion. Silver Lake inflows have nearly three times as much hardness as the Lake outflows. Given that inflows and outflows are nearly equal we surmise there is no large underground inflows. This indicates the something is happening to the hardness. Furture investigations will center around finding out what happens to the hardness and whether it may be feasible to add hardness ($CaCO_3$) to the inlet stream to raise the hardness, thus reducing toxicity. This work would require a raft and hydrolab be flown in by helicopter one to two times during a summer. We are currently exploring if the mining corporation who owns the lands under and surrounding the lake will help fund this program. The ultimate goal of the project would be to make Silver Lake a sustainable fishery with public easements for access.

LITTERATURE CITED - none

ATTACHMENT 1 – LOCATION MAP

Figure 2: Location of Injection and Sample Sites



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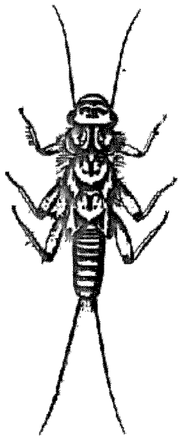
ATTACHMENT 2 – WATER QUALITY DATA

	ARRASTRA BASIN SURFACE WATER QUALITY DATA (2002 - 2004)											
Lab Na	Lab. Sample I.D.											
	Lab. Desig	**NEW SITE DESCRI**	**E DESIG**	DATE	TIME_24H	AGENCY	TYPE	FLOW_CF	EST_Q_GI	field pH	TEMP_C	field cond.
DOW	3603.001	Silver Lake Inlet	AB-1	7/28/02	12:30	ARSG	S			7.5	15.8	
DOW	3604.001	Silver Lake Outlet	AB-2	7/28/02	14:30	ARSG	S		15.80	7.84	17.1	
DOW	3605.001	Arrastra @ confluen	AB-6	7/28/02	17:00	ARSG	S		5.00	7.78	11.2	
DOW	3606.001	Arrastra blw flume	AB-5	7/28/02	18:30	ARSG	S			7.72	7.3	
DOW	3607.001	Arrastra blw Quonse	AB-3	7/28/02	19:45	ARSG	S			8.07	7.5	
DOW	3608.001	Arrarstra abv quonse	AB-4	7/28/02	20:30	ARSG	S			7.87	6.2	
DOW	3610.001	Arrastra above waterfall-1/3 m		7/28/02	15:30	ARSG	S		10.00	7.38	17.4	
DOW	3605.002	Arrastra @ confluen	AB-6	9/3/02	10:30	ARSG	S	2.987		7.89	7.6	244
DOW	3606.002	Arrastra blw flume	AB-5	9/3/02	13:00	ARSG	S	2.581		6.9	7.1	239
DOW	3607.002	Arrastra blw Quonse	AB-3	9/3/02	15:00	ARSG	S	0.857		8.17	6.9	252
DOW	3608.002	Arrarstra abv quonse	AB-4	9/3/02	13:45	ARSG	S	1.827		8.05	5.7	251
DOW	3605.003	Arrastra @ confluen	AB-6	6/12/2003	9:50	ARSG	S	27.788		7.48	4.6	114.7
DOW	3606.003	Arrastra blw flume	AB-5	6/12/2003	11:10	ARSG	S	28.450		7.47	4.7	113.8
DOW	3607.003	Arrastra blw Quonse	AB-4	6/12/2003	12:20	ARSG	S	20.400		7.5	4.6	95.8
DOW	3608.003	Arrarstra abv quonse	AB-3	6/12/2003	1:35	ARSG	S	22.000		7.56	4.1	120.3
DOW	3603.002	Silver Lake Inlet	AB-1	6/15/2003	13:30	ARSG	S	NA		6.88	2.2	51
DOW	3604.002	Silver Lake Outlet	AB-2	6/15/2003	15:30	ARSG	S	<18		6.58	3.8	51.2
DOW	3603.003	Silver Lake Inlet	AB-1	10/13/03	12:00	ARSG	S	0.176	79.08	7.46	7.3	142.3
DOW	3604.003	Silver Lake Outlet	AB-2	10/13/03	13:30	ARSG	S	0.067	30.24	7.25	8	64.7
DOW	3605.004	Arrastra @confluenc	AB-6	10/19/03	10:30	ARSG	S	3.429		7.62	5.1	258
DOW	3606.004	Arrastra blw flume	AB-5	10/19/03	12:00	ARSG	S	3.564		7.55	6.7	258
DOW	3607.004	Arrastra blw quonset	AB-4	10/19/03	13:30	ARSG	S			8.14	10.4	257
DOW	3608.004	Arrastra above quon	AB-3	10/19/03	15:00	ARSG	S			7.96	11.5	256
DOW		Arrastra @ confluen	AB-6	6/10/04	11:10	ARSG	S	v. high flow		7.53	5.3	91.9
DOW	3603.004	Silver Lake Inlet	AB-1	6/18/04	15:45	ARSG	S	6.635		6.33	1.9	41.6
DOW	3604.004	Silver Lake Outlet	AB-2	6/18/04	14:19	ARSG	S	7.387		6.17	1.5	47.5
DOW	3608.005	Arrarstra abv quonse	AB-3	6/19/04	14:10	ARSG	S	27.215		7.25	4.2	112.6
DOW	3607.005	Arrastra blw Quonse	AB-4	6/19/04	13:25	ARSG	S	23.415		7.28	6.2	103.2
DOW	3606.005	Arrastra blw flume	AB-5	6/19/04	12:15	ARSG	S	29.277		7.37	6.7	99.6
DOW	3605.005	Arrastra @ confluen	AB-6	6/19/04	11:20	ARSG	S	32.300		7.24	5.9	100.8

HARD_MG	Total alk.	CA_TOT_M	CA_DIS_M	MG_TOT_	MG_DIS_M	AL_TOT	AL_DIS	AS_TOT	AS_DIS	CD_TOT	CD_DIS	CU_TOT
as CaCO3	Mg/l											
26	20	12.055	12.14	0.501	0.53	<15	<15	<15	<15	<.15	-1.00	1.0
26	10	8.677	8.307	0.56	0.436	<15	81.0	<15	<15	2.89	0.59	49.6
110	44	40.051	39.323	2.025	2.012	<15	<15	<15	<15	1.61	1.64	6.1
116	28	41.683	38.284	2.09	1.938	<15	<15	<15	<15	1.99	1.74	8.1
118	46	42.756	41.924	2.267	2.271	<15	<15	<15	<15	0.35	0.37	1.7
122	52	42.635	42.724	2.233	2.28	<15	<15	<15	<15	0.36	0.35	2.1
-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9.00	-9.00	-9.0
108	46	39.012	38.982	1.941	1.938	<15	<15	<15	<15	1.49	1.50	5.4
122	48	39.344	39.282	1.949	1.95	<15	<15	<15	<15	1.74	1.69	6.6
118	54	40.631	40.359	2.087	2.064	<15	<15	<15	<15	0.31	0.33	1.6
122	52	41.586	20.69	2.144	1.054	<15	<15	<15	<15	0.29	0.15	2.0
		19.23	19.15	0.903	0.885	18	<15	<15	<15	0.86	0.83	7.1
		19.95	19.46	0.917	0.854	46	<15	<15	<15	0.85	0.87	8.4
		19.63	19.78	0.955	0.966	20	<15	<15	<15	0.51	0.48	5.1
		18.58	18.93	1.026	0.979	<15	<15	<15	<15	0.55	0.45	4.2
		7.88	7.93	0.266	0.252	35	16	<15	<15	<.15	<.15	<1
		7.80	7.78	0.312	0.296	32	<15	<15	<15	1.67	1.66	18.8
68.0	20	25.129	25.095	1158	1140	<15	<15	<15	<15	<.15	<.15	<1
28.0	12	10.029	9986	0.437	0.443	<15	<15	<15	<15	0.84	0.79	10.1
		42.06	41.283	2.16	2.117	<15	<15	<15	<15	1.47	1.42	5.5
		41.15	41.471	2.101	2.105	<15	<15	<15	<15	1.45	1.47	6.3
		43.013	42.852	2.353	2.357	<15	<15	<15	<15	0.36	0.31	1.6
		43.023	43.329	2.407	2.319	<15	<15	<15	<15	0.29	0.32	1.2
36.0	26					<15	<15	<15	<15			

Lab analysis complete but data in this area is jammed up in a CDOW computer problem.
Expect to be able to retrieve data in January, 2005.

CU_DIS	**FE_TOT**	**FE_DIS**	MN_TOT	MN_DIS	PB_TOT	PB_DIS	SE_TOT	SE_DIS	ZN_TOT	ZN_DIS	Sampler
1.1	<10	<10	<10	<10	<3	<3	<2	<2	<1	12.2	Simon, Anderson
7.7	326.0	24.0	580.7	14.9	104.8	4.2	<2	<2	531.1	100.6	Simon, Anderson
5.9	25.0	11.0	<10	<10	3.5	<3	<2	<2	178.3	187.6	Simon, Anderson
8.3	<10	<10	<10	<10	3.0	3.5	2.9	2.3	245.9	228.7	Simon, Anderson
2.3	<10	11.0	<10	<10	<3	2.3	<2	<2	40.1	50.4	Simon, Anderson
2.0	<10	<10	<10	<10	<3	<3	2.5	<2	47.2	59.3	Simon, Anderson
-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	Simon, Anderson
4.9	<10	<10	<10	<10	<3	<3	<2	<2	151.5	151.3	Alcon, Simon
6.3	<10	<10	<10	<10	2.4	<3	<2	<2	187.6	188.2	Alcon, Simon
1.3	23.0	0.0	<10	<10	<3	<3	3.8	2.5	29.4	30.1	Alcon, Simon
0.5	<10	<10	<10	<10	<3	<3	3.1	<2	36.5	18.7	Alcon, Simon
7.2	12	<10	<10	<10	<3	<3			122.8	123.4	K. Zillich
7.6	30	<10	<10	<10	3.6	<3			128.1	125.6	K. Zillich
5.2	<10	<10	<10	<10	<3	<3			65.5	65.6	K. Zillich
4.2	10	<10	<10	<10	1.0	1.5			60.6	64.1	K. Zillich
<1	17	<10	<10	<10	<3	<3			<1	13.2	Simon
20.8	<10	17	42.9	44.5	12.7	8.5			283.7	283.4	Simon
<1	<10	<10	<10	<10	<3	<3	<2	<2	<1	<1	Wright, Simon
6.9	33	14	28.9	21.9	8.7	5.1	<2	<2	166.2	154.9	Wright, Simon
5.2	15	<10	<10	<10	3.7	<3	<2	<2	185.4	180.1	Simon, Zillich
6.4	14	19	<10	<10	7.7	5.4	<2	<2	179.9	181.8	Simon, Zillich
1.9	10	<10	<10	<10	5.4	<3	<2	<2	32.3	31.7	Simon, Zillich
1.2	<10	<10	<10	<10	<3	<3	<2	<2	42.7	42.3	Simon, Zillich
											Simon
											Owen, Simon
											Owen, Simon
											Zillich, Simon
											Zillich, Simon
											Zillich, Simon
											Zillich, Simon



ATTACHMENT 3

Macroinvertebrate Survey of Arrastra Creek, 2002

Chester Anderson
B.U.G.S. Consulting (**B**ioassessment **U**nderwater, **G**raphs and **S**tatistics)
P.O. Box 1645
Ignacio, CO 81137
(970) 563-9383

For the Animas River Stakeholders Group, Silverton Colorado

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Purpose

The purpose of this survey had 4 components:

1. to identify the quality of macroinvertebrate communities throughout Arrastra Creek,
2. to determine if there was a food source for trout,
3. to identify changes in community composition of macroinvertebrates from above Silver Lake to the Confluence with the Animas and,
4. to relate the changes in macroinvertebrate community composition to changes in water quality parameters.

Arrastra Creek is a tributary of the Upper Animas River above Silverton Colorado. There have been significant amounts of mining activity in the watershed as indicated by numerous tailing piles, abandoned tramlines and mine shafts visible from the stream. Although the Animas River supports trout where Arrastra Creek enters the River, Arrastra Creek itself does not contain trout. There are no natural barriers within Arrastra Creek that would prevent trout from migrating upstream. Cunningham Creek, the next tributary to the Animas upstream from Arrastra does support trout.

A reconnaissance of macroinvertebrate communities was conducted in June 2002. The purpose of the reconnaissance was to identify and narrow the scope of potential sample sites where more rigorous sampling of macroinvertebrates and collection of water quality samples would take place. The reconnaissance began at the Above Quonset sample site (fig. 1, table 1) and proceeded to the confluence of Arrastra Creek with the Animas. Macroinvertebrates were collected with a Surber net and placed in a white pan with water. Macroinvertebrates were identified in the field and a rough estimate of relative density was obtained. Substrate quality was also noted.

The reconnaissance identified large changes in macroinvertebrate communities from the Above Quonset sample site to the Below Flume sample site (fig. 1, table 1). At the Above Quonset sample site, the community was dominated by mature larvae of the predatory, Perlodid Stonefly, *Megarcys*. Downstream, 0.5 kilometers at the Below Quonset sample site, large, grazing mayflies from the family Heptageniidae dominated the community and no *Megarcys* were present. Another 0.5 km downstream the community became more diverse with only immature larvae of *Megarcys* and Heptageniidaes. In this reach, the stream also changed from a mossy bottom stream with some adnate algae to a stream composed only of adnate algae and then back to a stream dominated by moss. At the confluence with the Animas River, the cobble substrate of Arrastra Creek was covered with adnate algae without any noticeable quantities of moss. The macroinvertebrate community did not appear to be significantly different from the community at the Below Flume site.

This reconnaissance revealed that there were significant changes in macroinvertebrate communities and therefore in water quality within the reach from Above Quonset to Below Flume sample sites and little if any significant changes in water quality from Below Flume to the confluence. Downstream from the Below Quonset sample site there existed an old diversion that was diverting some stream water. On the west slope approximately 100 meters above and away from the stream a mine shaft and tailings pile could be seen. Above the diversion near the Below Quonset sample site were remnants of mine tailings adjacent to the creek.

It was also known that Silver Lake, 1.5 miles upstream from the Above Quonset sample site, contained large quantities of tailings and had several mine sites within a mile of the water. Because the lake was a relatively difficult drive and hike it was decided that sampling would be a 1-time event without the reconnaissance. Sample sites would be selected based on observations at the time of sampling.

Field Sampling

The more rigorous macroinvertebrate sampling and water chemistry sampling occurred on July 28th, 2002 at 9 sites from above Silver Lake to the Confluence with Arrastra Gulch (fig. 1, table 1). Riffles were sampled for macroinvertebrates with a Surber sampler. Samples consisted of 3 composited surber samples taken from the same riffle; 1 from the near edge of the stream, 1 from the middle and 1 from the far edge beginning at the bottom of the riffle and working diagonally across and upstream. Water chemistry samples were obtained upstream from the macroinvertebrate samples. Macroinvertebrate samples were composited, labeled and preserved in 90% ethanol. Photographs of each sample site was taken. Flow was estimated based on data collected in 1991 at 2 sites, A59 near the Above Quonset sample site and A58 near the @ Confluence site.

Table 1. Station number, name, elevation and estimated flows that were sampled July 28th, 2002 for macroinvertebrates and water chemistry.

Station Number	Station Name	Elevation	Surface flow (estimated)
3603.001	Silver Lake Inlet	12190	0.5
	Silver Lake	12185	
3604.001	Below Sliver Lake	12180	0.5
	Above Drop to Mayflower (only macros sampled)	11900	0.1
3608.001	Above Quonset	10000	8.26
3607.001	Below Quonset	9920	9
	Rock Flume (only water chemistry sampled)		
3606.001	Below Flume	9800	10
3605.001	@ Confluence	9540	13.19

Sample Processing

Prior to processing the macroinvertebrate samples, large woody debris was rinsed and removed from the samples and the remaining material and macroinvertebrates were evenly distributed in a white, gridded tray. Processing consisted of a 100 fixed count method from randomly selected grids. Specimens were identified to at least the taxonomic level of family.

Metrics from the Rapid Bioassessment Protocols II were calculated except for community loss metric (no. 7) since no reference site was identified or sampled. Metrics calculated included 1) Taxa

Richness) Family Biotic Index (FBI), 3) Ratio of Scrapers to Collector + Gatherers, 4) Ratio of Ephemerella, Plecoptera, Trichoptera (EPT) to Chironomidae, 5) Percent Dominant Taxa, 6) EPT taxa and 8) Ratio of Shredder to Total Taxa. Also calculated were the Shannon-Weiner and Simpons Diversity Indexes.

Sample Site Descriptions

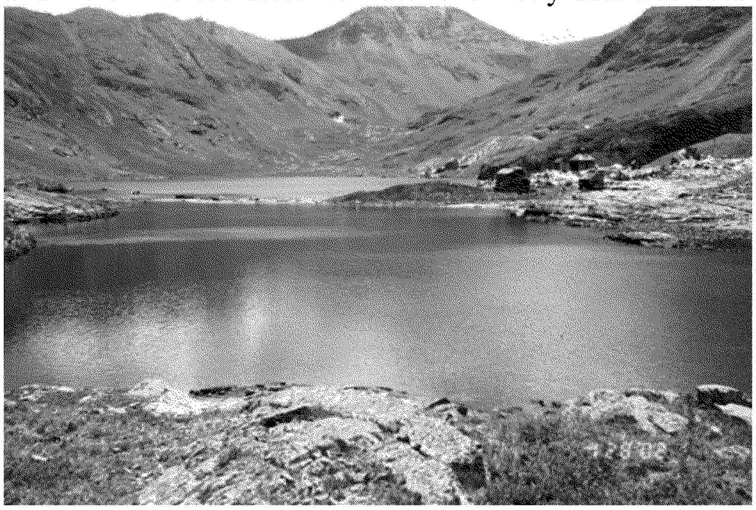
Silver Lake Inlet

At this site Arrastra Creek was approximately 0.5 meters wide with less than 5cm of water flowing over pebble to boulder size substrate. Substrate was covered with adnate algae (fig. 2).

Figure 2. Silver Lake Inlet sample site.

Silver Lake

At this site the frame of the surber net was attached to a rope in 3 places and thrown into the lake and allowed to settle to the bottom. Then the net was pulled through the water to capture pelagic macro and meio invertebrates. No water chemistry data was obtained from this site (fig. 3).



Below Silver Lake

Arrastra Creek at this sample site was similar in size to the Silver Lake Inlet sample site. Water flowed over boulder and bedrock substrate that was covered with adnate algae (fig. 4).

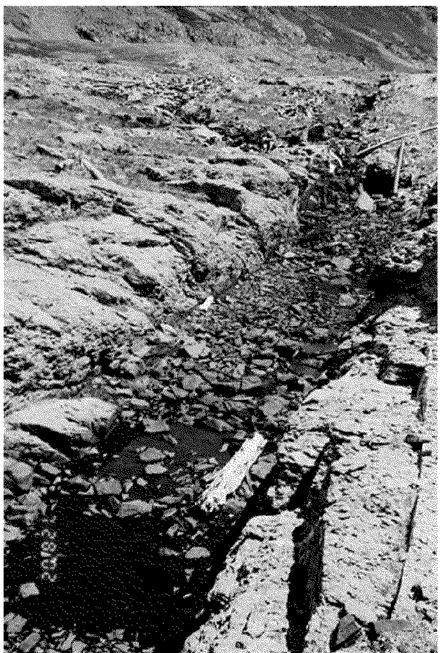


Figure 4. Below Silver Lake sample site.

Above Drop to Mayflower

At this site the creek was small and warm with very little water running over boulders and bedrock. Wet substrate was covered with a small amount of adnate algae. Only macroinvertebrates were sampled at this site (fig. 5). Below this site there was no more surface water in the creek bed to at least the drop to the Mayflower mine.

Figure 5. Above Drop to Mayflower sample site.

Above Quonset

This sample site was approximately 100 ft below the confluence with the stream that came out of Little Giant Basin. Substrate was composed of boulder and cobble and covered mostly by moss and some adnate algae. The wet width was approximately 3 feet (fig. 6).

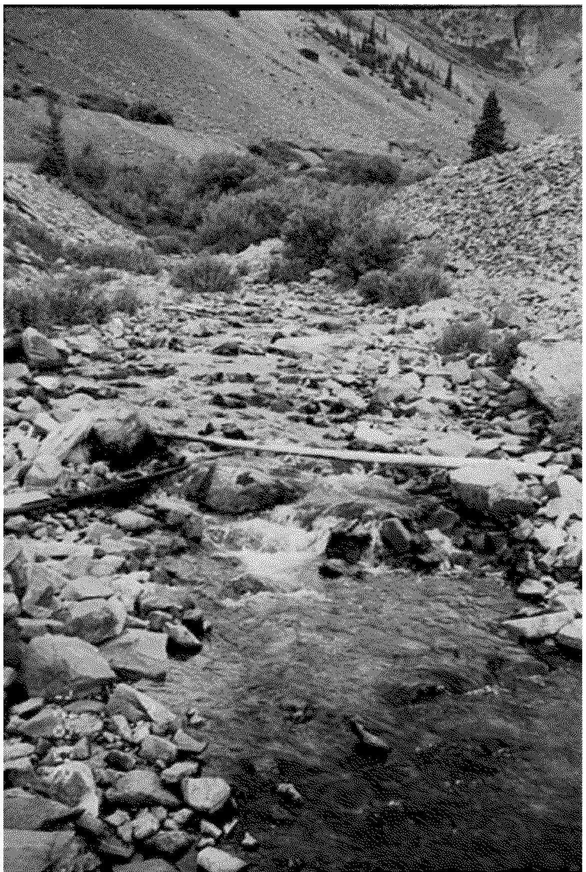


Figure 6. Above Quonset sample site.

Below Quonset

This site had no apparent difference in flow from the Above Quonset site. Moss was conspicuously absent and the boulder/cobble substrate was covered with adnate algae (fig. 7).

Figure 7. Below Quonset sample site.

Flume

This site was a flume that ran through the boulders approximately 30ft west of the creek and was a result of an old, dilapidated diversion approximately 200 yards upstream. Only water chemistry was

sampled at this site No photograph was taken.

Below Flume

This site had no apparent difference in flow from either the Above or Below Quonset sample sites. Substrate was boulder/cobble and covered by large quantities of moss (fig. 8).

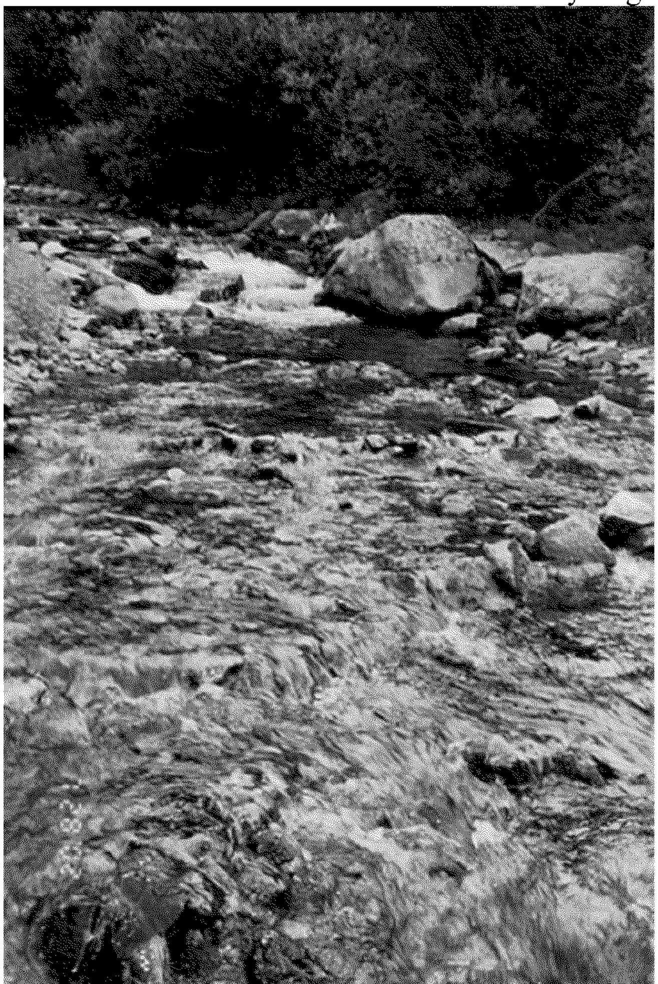


Figure 8. Below Flume sample site.

@ Confluence

Stream flow appeared to be slightly greater at this site. Gradient was also higher than at the other sample sites. Adnate algae covered the boulder/cobble substrate (fig. 9).

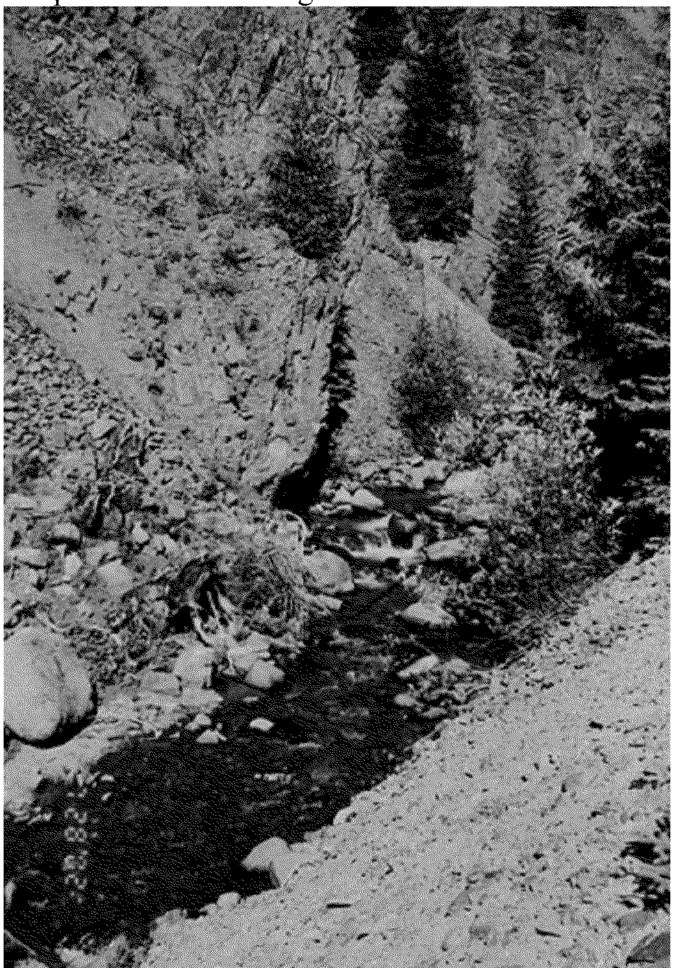


Figure 9. @ Confluence sample site.

Results

Sample Site Characteristics

Data obtained from a USGS 7.5'Quadrangle map showed stations ranging in elevation from 9,150ft at the @ Confluence sample site to 12,190ft at the Silver Lake Inlet sample site. Stream distance between the confluence and the Silver Lake Inlet sample site was 3.4 miles. The creeks from Woodchuck and Little Giant Basin appeared to be the only significant sources of water to Arrastra Creek within the stream reach that was sampled and within the time frame of sampling (figs. 1-10).

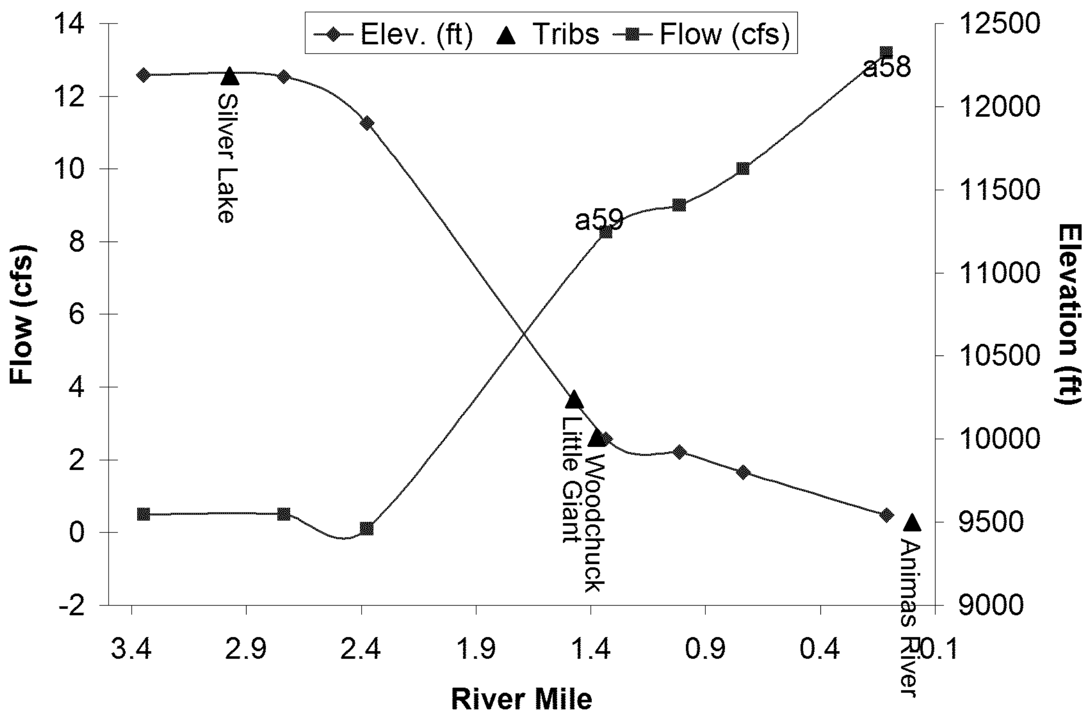


Figure 10. Station elevations, estimated flow, and location of major tributaries.

Given characteristics such as river mile, elevation and stream size (using estimated flow, see 1991 data and photos below) the stations group into 3 reaches, I) a reach above mile 2 that includes the Silver Lake Inlet, Below Silver Lake, and Above Drop to Mayflower sample sites, II) a reach below mile 2 that includes Above Quonset, Below Quonset, and Below Flume Sample Sites and III) a reach that includes the sample site at the confluence. The groupings are important when comparing macroinvertebrate communities. Therefore changes in macroinvertebrate communities are only discussed within each reach.

Macroinvertebrate Data

Within reach 1 there were important differences in macroinvertebrate communities between the Silver Lake Inlet sample site and the 2 sample sites downstream from the lake. Although Simpson's Diversity increased from upstream to downstream, RBP metrics such as FBI, EPT, and taxa richness

indicated declining health in the macroinvertebrate communities below Silver Lake as well as the Shannon Wiener Diversity index (figs. 11, & 12, tables 2 & 3).

Within reach 2 there were large differences in community compositions given the relatively small changes in stream mile, elevation, and flow. RBP metrics 1, taxa richness, and 6, Ephemerella, Plecoptera, Trichoptera (EPT) index and both Simpon's and Shannon-Wiener Diversity Indeces showed a decrease in health of the macroinvertebrate community from Above Quonset to Below Quonset and an increase in health from Below Quonset to a high point in macroinvertebrate community health at the Below Flume sample site. The FBI index indicated a general decrease in community health from the Above Quonset sample site to the Below Flume sample site. RBP metric 3, Ratio of Scrapers to Collector + Gatherers, and metric 4 Ratio of Ephemerella, Plecoptera, Trichoptera (EPT) to Chironomidae showed an increase in community health from the Above Quonset sample site to the Below Quonset sample site and a decrease to the Below Flume sample site. Courtney and Clements (2002) suggested use of Heptageniids as a metric because of their sensitivity to high concentrations of metals shows a similar but stronger trend. Regardless of the interpretation of community health from the macroinvertebrate data within reach 2, there was indication of effects of increasing concentration of metals on the macroinvertebrate communities due to the large changes in community compositions within this reach.

Data of the composition of the macroinvertebrate community at the @ Confluence sample site indicates no significant increase in toxicity of water chemistry or decline in substrate quality from the above reach. It is interesting to note that there was very little impact of precipitates to the benthos at any of the sample sites, unlike the obvious impacts found in the Animas, Mineral and Cement Creeks.

Table 2. Macroinvertebrate data.

		Silver Lake Inlet, 3603.001	**50yds Below Sliver Lake 3604.001**	**Above Drop to Mayflower 3610.001**	**Above Quonset 3608.001**	**Below Quonset 3607.001**	**Below Flume 3606.001**	**@ Confluence 3605.001**
Family	***Genus***							
Baetidae	Baetis	80	21	19	11	37	33	12
Ephemerellidae	Drunella					2		
Heptageniidae	Cinygmula					4		
Heptageniidae	Epeorus				5	35	13	9
Heptageniidae	Rhithrogena					13	7	58
Perlodidae	Megarcys				31		10	2
Siphlonuridae	Ameletus						2	
Acari				2				
Ceratopogonidae							1	

Chloroperlidae	1						
Chironimidae	11	20	62	36	9	36	
Dytiscidae		4	10				
Nemouridae				14		17	12
Planariidae	3			2	1	4	6
Ryacophilidae		6		4	2	14	8
Simulidae	3		4			1	3
Tipulidae	2						
River mile	3.35	2.74	2.38	1.33	1.01	0.74	0.11
Elev. (ft)	12190	12180	11900	10000	9920	9800	9540
Flow (cfs)	0.5	0.5	0.1	8.26	9	10	13.19

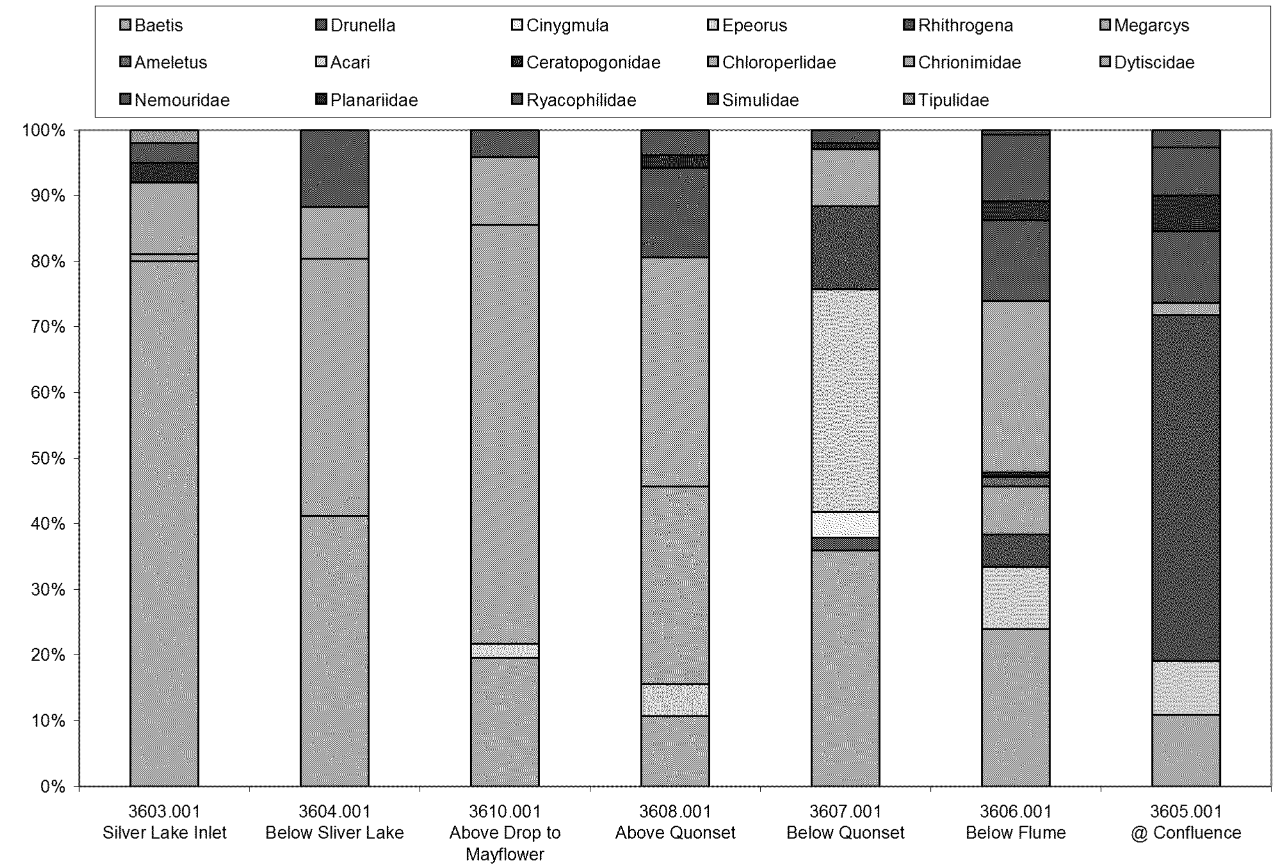
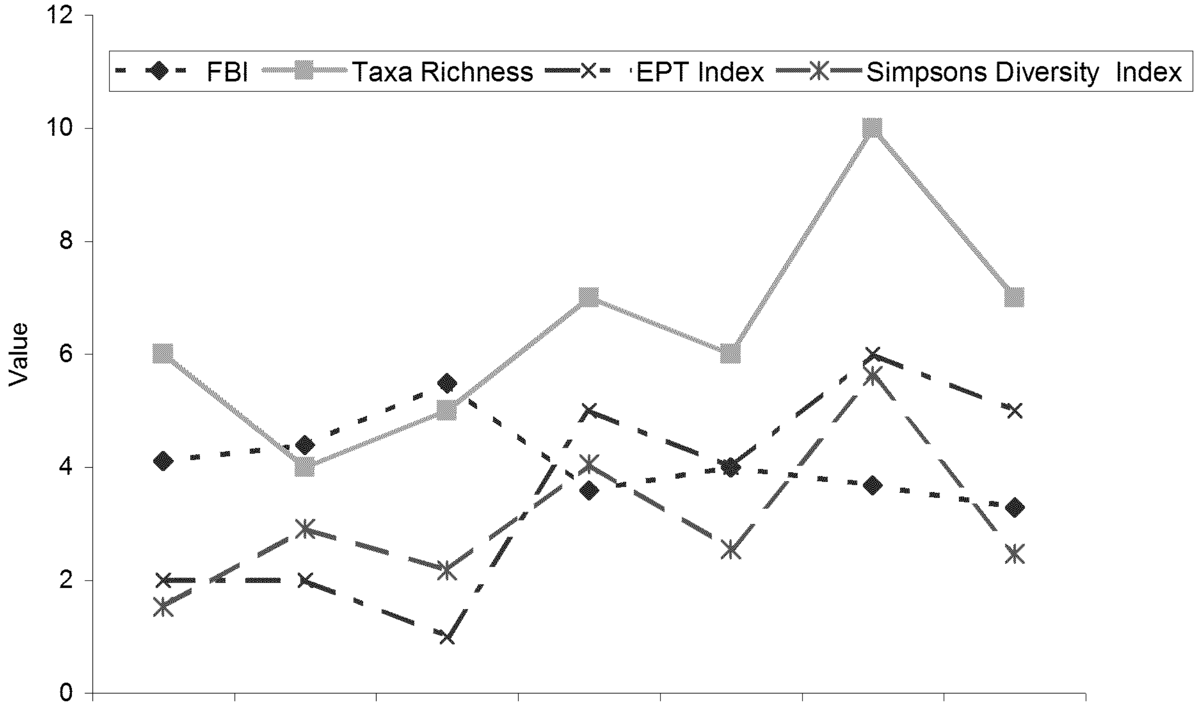


Figure 11. Composition of macroinvertebrate communities. The change in compositions from Above Quonset to Below Flume is high given the relatively small change in stream mile, elevation, and flow. Given the presence of *Megarcys* and the Heptageniid Mayflies it appears that the stretch from Above Quonset to the Confluence would support trout. The absence of Caddisflies appears to be elevational given data from streams with similar altitudes near the Rocky Mountain Biological Laboratory, Gothic, Colorado.

Table 3. Rapid Bioassessment (RPB II, EPA), metrics. No Community Loss calculated because there was no designated refernce sations. Shannon Weiner and Simpsons Diversity indeces also included.

				Metric:		1		2			3		4		5		6
Station	**Coll**	**Det**	**Filt**	**Gath**	**Pred**	**Taxa Richness d**	**No. Individuals n**	**FBI**	**No. of Scraper (S)**	**Filt+Coll (F+C)**	**Ratio of S/(F+C)**	**No. of Chiros**	**Ratio of EPT/Chiro**	**No. Dom. Taxa**	**% Dom. Taxa**	**No. EPT**	**EPT Index**
Silver lake inlet	91	0	3	0	6	6	100	4.11	0	94	0.00	11	7.36	80	80.00%	81	2
Below Sliver Lake	41	0	0	0	10	4	51	4.39	0	41	0	20	1.35	21	41.18%	27	2
Above Drop to Mayflower	83	0	4	0	10	5	97	5.48	0	87	0.00	62	0.31	62	63.92%	19	1
Above Quonset	47	0	0	0	51	7	103	3.59	5	47	0.1064	36	1.81	36	34.95%	65	5
Below Quonset	48	0	0	0	3	6	103	4.00	52	48	1.08	9	10.33	52	50.49%	93	4
Below Flume	71	0	1	0	46	10	138	3.68	20	72	0.2778	36	2.67	36	26.09%	96	6
@ Confluence.	12	0	3	0	28	7	110	3.29	67	15	4.4667	0	#DIV/0!	67	60.91%	101	5

		8		
Station	**Shredd Abund**	**Ratio Shred/ Tot**	**Shannon Weiner Index**	**Simpsons Diversity**
Silver lake inlet	0	0	18.96073	1.5281174
Below Sliver Lake	0	0	7.508994	2.912654
Above Drop to Mayflower	0	0	12.41995	2.1754913
Above Quonset	0	0	17.69976	4.0507827
Below Quonset	0	0	17.66269	2.5484026
Below Flume	0	0	30.34248	5.6143868
@ Confluence.	0	0	19.0659	2.4744376



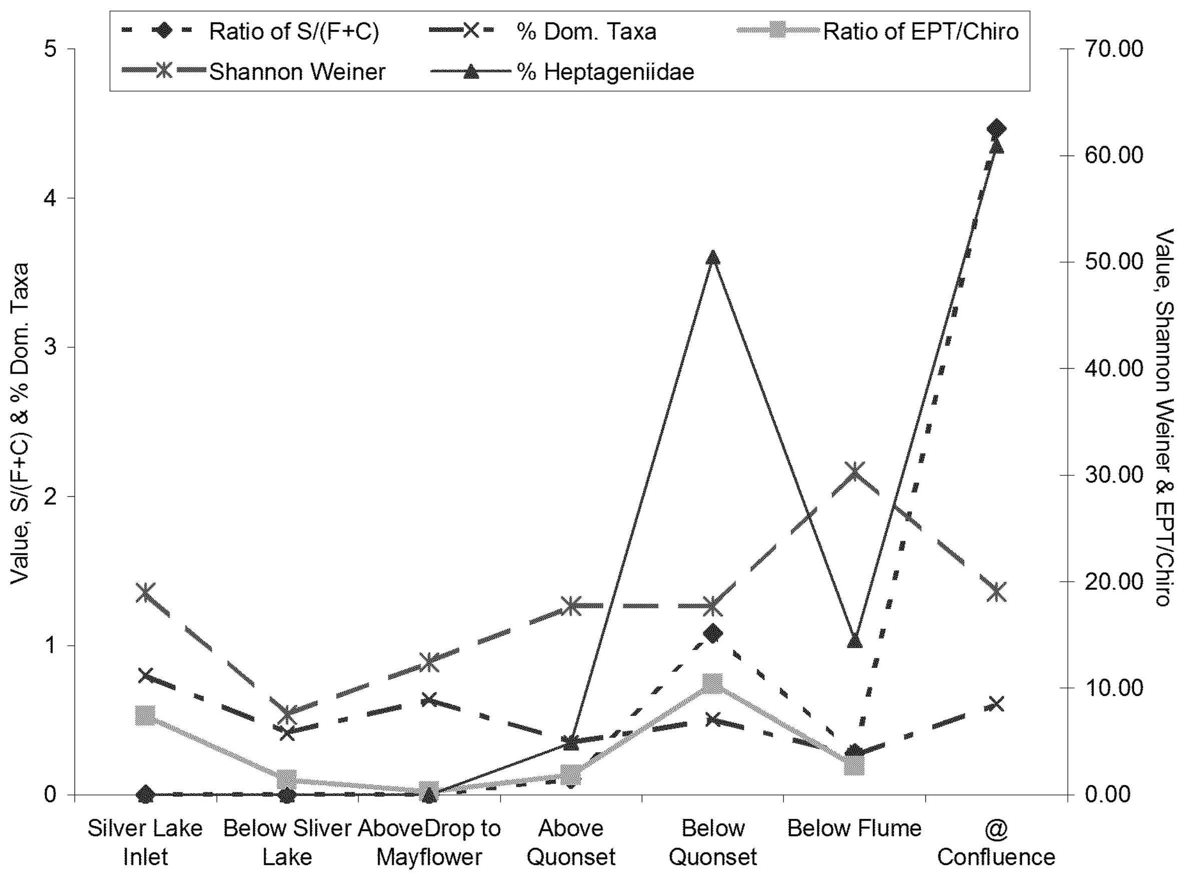


Figure 12. Graphical presentation RBPII metrics.

Water Chemistry Data

Within reach 1, the Silver Lake Inlet sample site had low hardness and low concentrations of metals (Figures 13-15). The 2 sample sites below the lake had elevated concentrations of metals and low hardness resulting in greater toxicity. Between reach 1 and reach 2 there was a substantial increase in total hardness, calcium, alkalinity and magnesium. Within reach 2, between the Below Quonset Hut sample site and the Below Flume sample site, there was an increase in concentrations of cadmium, copper, zinc and lead. Given the higher values of hardness at the Below Flume sample site the corresponding increase in metals would not result in toxicity values being as high as at the 2 sample sites below Silver Lake. But, given the size of and the fact that a large portion of the stream may be flowing through the alluvium at the Below Flume sample site, the load to the stream would be much greater within this reach than from Silver Lake where the stream was much smaller and flowed across bedrock with little alluvial material.

Relationship Between Macroinvertebrate and Water Chemistry Data

In general, macroinvertebrate communities reflected what would be expected given the concentration of metals and hardness of water found at each sample site (Tables 2, 3 & 4, Figures 11-15). Although the Silver Lake Inlet sample site had low hardness and low concentrations of metals and appeared relatively pristine, given the altitude and small stream size at this sample site a more diverse macroinvertebrate community would not be expected. The sample sites below the lake had elevated concentrations of metals and low hardness resulting in high toxicity of the metals and the macroinvertebrate communities at these sites reflected this toxicity.

Data from reach 2 were more difficult to interpret. Hardness was higher for each sample site within this reach but the concentration of metals did not increase substantially until at the Below Flume sample site (Figures 13-15). Some macroinvertebrate community metrics within reach 2 indicated increasing health, others indicated decreasing health (Table 3, Figure 12). Acute toxicity at the Below Flume Site may not have been much of a contributor to macroinvertebrate community composition due to high hardness values. Chronic toxicity, because of higher concentrations of metals, may have been
more significant. Because of the relatively small distance between sample sites, downstream drift and colonization from upstream, relatively healthy macroinvertebrate communities may be masking the effects of increasing concentrations of metals.

Conclusions

Other than below Silver Lake, macroinvertebrate communities in Arrastra Creek were relatively diverse and dense and appeared to be in sufficient quantity to support trout. Calculating relative load of various metals to the Animas River and its significance to downstream recovery may be important to remediation efforts. Depending on the results of these calculations it may be important to locate the source of metals within the reach 2 (Above Quonset to Below Flume) of Arrastra Creek.

Table 4. Water chemistry values.

Station	Flow (estimated)	pH	Temp. (C°)	Phen. Alkalinity	Total Alkalinity	Total Hardness
Silver Lake Inlet	0.5	7.50	15.8	0.0	20.0	26.0
Below Sliver Lake	0.5	7.84	17.1	0.0	10.0	26.0
Above Quonset	8.26	7.87	6.2	0.0	52.0	122.0
Below Quonset	9	8.07	7.5	0.0	46.0	118.0
Rock Flume	9.5	7.60	5.1	0.0	44.0	114.0
Below Flume	10	7.72	7.3	0.0	28.0	116.0
@ Confluence	13.19	7.78	11.2	0.0	44.0	110.0

STATION	Al Diss (ug/l)	AL Tot (ug/l)	AS Diss (ug/l)	AS Tot (ug/l)	CA Diss (ug/l)	CA Tot (ug/l)	CD Diss (ug/l)	CD Tot (ug/l)	CU Diss (ug/l)	CU Tot (ug/l)	FE Diss (ug/l)	FE Tot (ug/l)	MG Diss (ug/l)	MG Tot (ug/l)	MN Diss (ug/l)	MN Tot (ug/l)
Silver Lake Inlet	0.0	0.0	0.0	0.0	12140.0	12055.0	0.00	0.00	1.1	1.0	0.0	0.0	530.0	501.0	0.0	0.0
Below Sliver Lake	0.0	81.0	0.0	0.0	8307.0	8677.0	0.59	2.89	7.7	49.6	24.0	326.0	436.0	560.0	14.9	580.7
Above Quonset	0.0	0.0	0.0	0.0	42724.0	42635.0	0.35	0.36	2.0	2.1	0.0	0.0	2280.0	2233.0	0.0	0.0
Below Quonset	0.0	0.0	0.0	0.0	41924.0	42756.0	0.37	0.35	2.3	1.7	11.0	0.0	2271.0	2267.0	0.0	0.0
Rock Flume	0.0	0.0	0.0	0.0	36673.0	36907.0	1.83	1.59	5.3	5.4	0.0	10.0	1985.0	2005.0	0.0	0.0
Below Flume	0.0	0.0	0.0	0.0	38284.0	41683.0	1.74	1.99	8.3	8.1	0.0	0.0	1938.0	2090.0	0.0	0.0
@ Confluence	0.0	0.0	0.0	0.0	39323.0	40051.0	1.64	1.61	5.9	6.1	11.0	25.0	2012.0	2025.0	0.0	0.0

STATION	PB Diss (ug/l)	PB Tot (ug/l)	Se Diss (ug/l)	Se Tot (ug/l)	Zn Diss (ug/l)	Zn Tot (ug/l)
Silver Lake Inlet	0.0	0.0	0.0	0.0	12.2	0.0
Below Sliver Lake	4.2	104.8	0.0	0.0	100.6	531.1
Above Quonset	0.0	0.0	0.0	2.5	59.3	47.2
Below Quonset	2.3	0.0	0.0	0.0	50.4	40.1

Rock Flume	3.4	3.6	0.0	3.4	197.4	197.1
Below Flume	3.5	3.0	2.3	2.9	228.7	245.9
@ Confluence	0.0	3.5	0.0	0.0	187.6	178.3

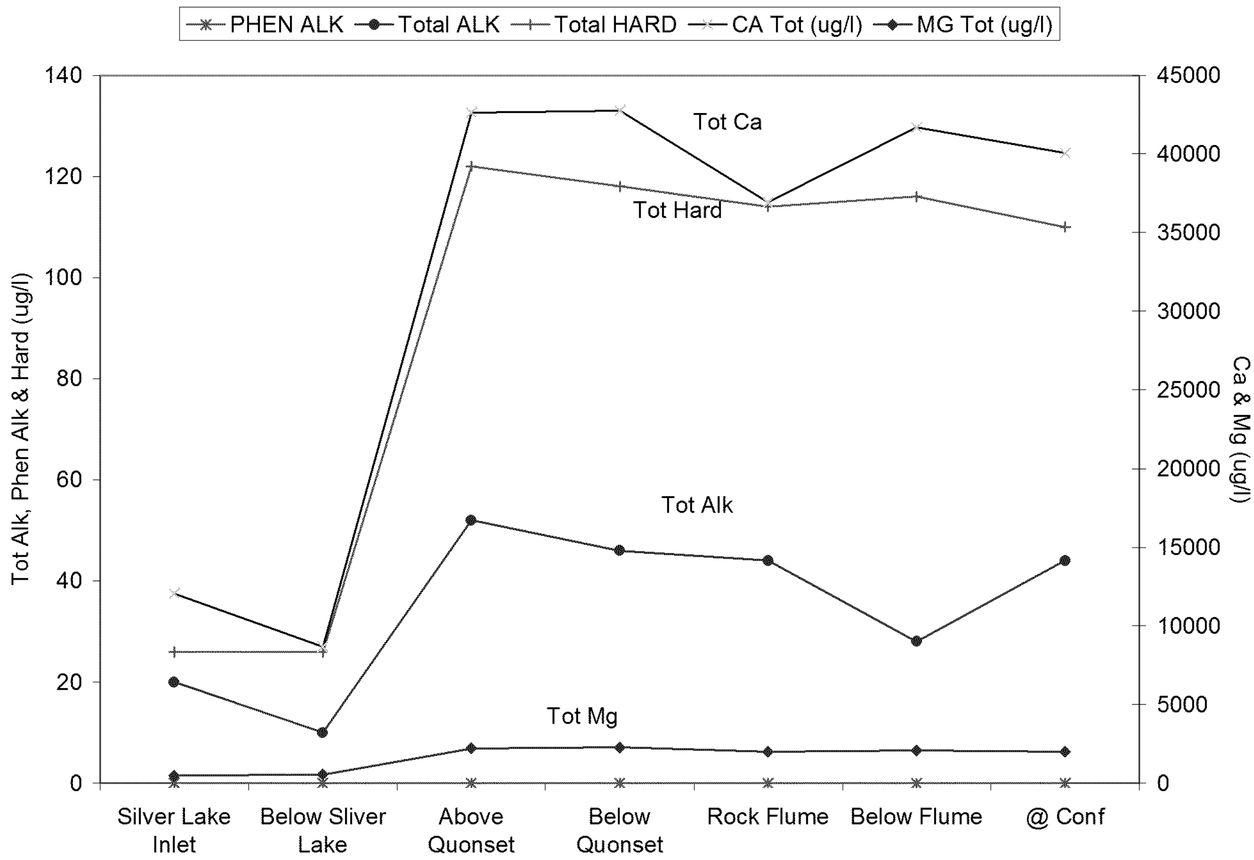


Figure 13. Concentration of total calcium, hardness, alkalinity magnesium and phenol alkalinity (ug/l).

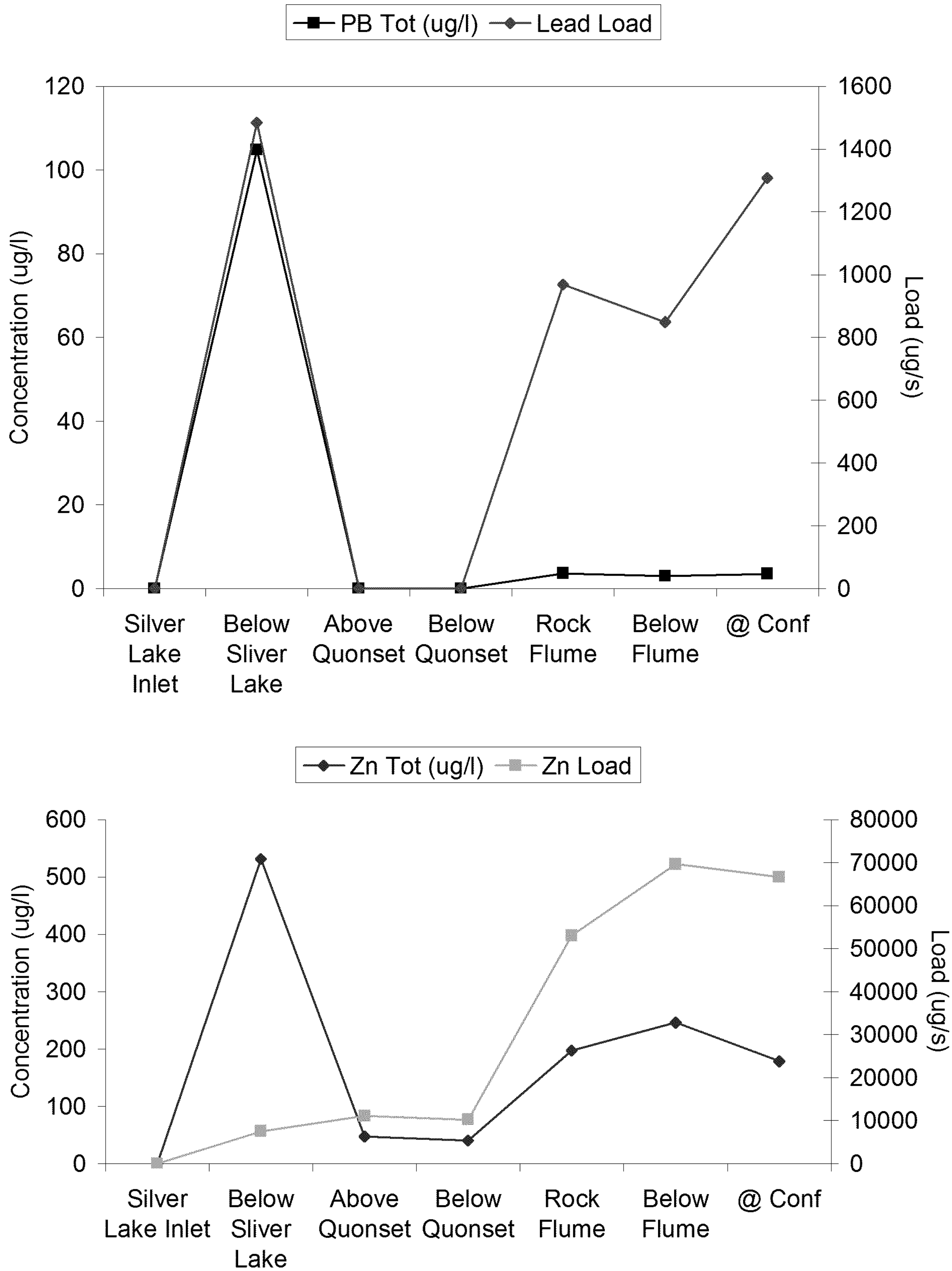
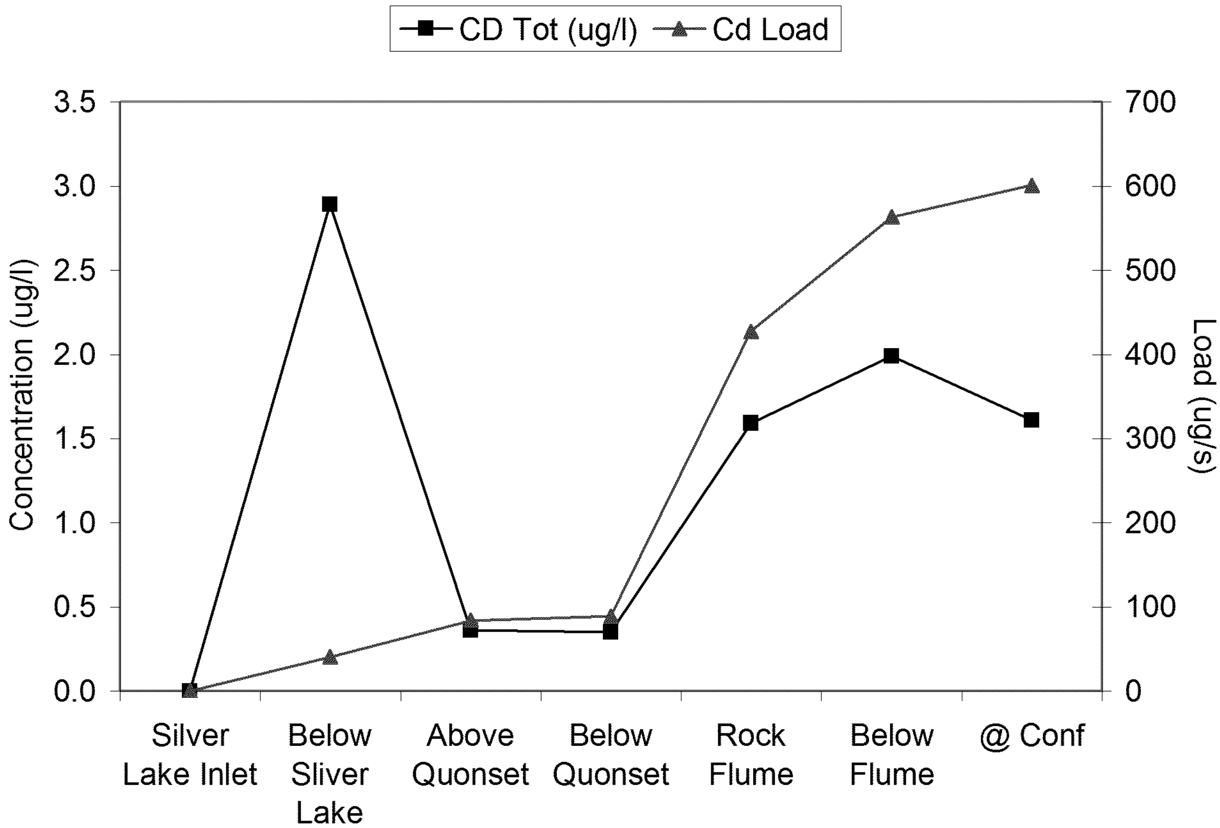


Figure 14. Concentration and estimated load of lead (upper graph) and zinc (lower graph).



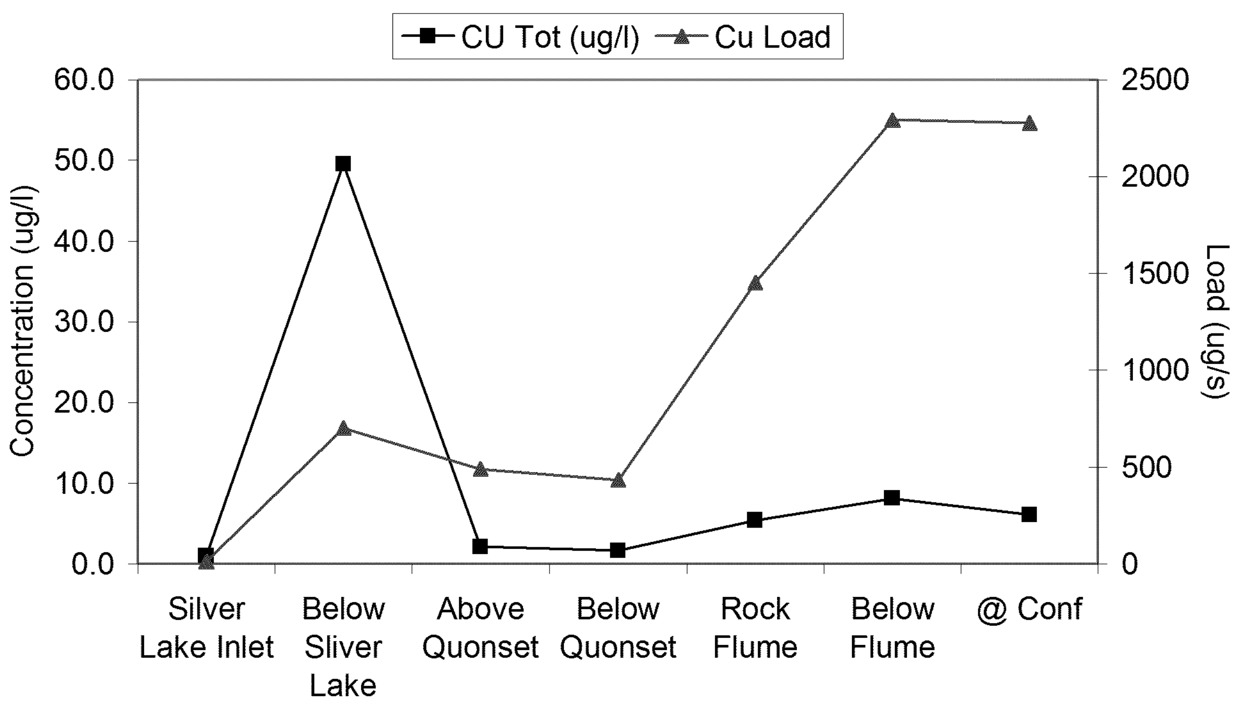


Figure 15. Concentration and estimated load of cadmium (upper graph) and copper (lower graph).

Reference

Lisa A. Courtney and William H. Clements. 2002. Assessing the influence of water and substratum quality on benthic macroinvertebrate communities in a metal-polluted stream: an experimental approach. Freshwater Biology (2002) 47, 1766–1778

ATTACHMENT 4

PARTICIPANT LIST
of the
ANIMAS RIVER STAKEHOLDERS GROUP

Federal Entities

Bureau of Reclamation
Bureau of Land Management
U.S. Forest Service

U. S. Geological Survey
Army Corps of Engineers

Colorado Agencies

Division of Wildlife
Division of Minerals and Geology
Colorado Department of Public Health and Environment
Colorado Riverwatch Program
Environmental Protection Agency*

Local Agencies

Southwestern Water Conservation District
San Juan Resource, Conservation and Development
Town of Silverton
City of Durango*
San Juan County*

Citizens Groups

San Juan Citizens Alliance
Western Colorado Alliance
Friends of the Animas River
River Watch Network, Inc.
Taxpayers for Animas River
Colorado River Alliance
San Juan County Historical Society

Private Entities

Gold King Mining Co.
Root and Norton Assayers
Silver Wing Co., Inc.*
Howardsville Mill
Echo Bay Mining
Sunnyside Gold Corp.
Durango and Silverton Narrow Gauge Railroad
Mining Remedial Recovery Company
Alpine Environmental Service

Plus numerous citizens from Silverton, Durango, and absentee property owners from throughout the nation